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Qualitative Analysis and Treatment of Lake Water

Hemalatha H N[1], Druthi Prasad[2], Shambhavi B M[2], Abhinandan T C[2], Siddarth[2]
[1]Assistant Professor, Department Of Civil Engineering, JSS Academy Of Technical Education, Bangalore, India
[2]Student, Department Of Civil Engineering, JSS Academy Of Technical Education, Bangalore, India
*Corresponding Author: * Hemalatha H N*

Abstract: *Water is the most important in shaping the land and regulating the climate. It is one of the most important compounds that profoundly influence life. The quality of water usually described according to its physical, chemical and biological characteristics. Rapid industrialization and indiscriminate use of chemical fertilizers and pesticides in agriculture are causing heavy and varied pollution in aquatic environment leading to deterioration of water quality and depletion of aquatic biota. Due to use of contaminated water, human population suffers from water borne diseases. It is therefore necessary to check the water quality at regular interval of time. Parameters that may be tested include temperature, pH, turbidity, salinity, nitrates and phosphates. An assessment of the aquatic macro invertebrates can also provide an indication of water quality.*

Keywords: *Alkalinity, Biochemical Oxygen Demand (BOD), Dissolved Oxygen (D.O.), Water Quality parameters.*

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I. Introduction

Lake is an area filled with water, localized in a basin that is surrounded by land, apart from any river or other outlet that serves to feed or drain the lake.Healthy lakes indicate healthy and eco-friendly life style of the people in its neighborhood. Lakes play a pivotal role in maintaining the ecological balance. Lake water is generally used for drinking, domestic and irrigation purposes. Therefore, it should be free from the pollutants. Although lakes contain 50.01 % of all the water on the Earth's surface, they hold 49.8 % of the liquid surface freshwater. Many organisms depend on freshwater for survival and humans frequently depend on lakes for a great many 'goods and services' such as drinking water, waste removal, fisheries, agricultural irrigation, industrial activity and recreation. For these reasons lakes are important ecosystems[1].Water quality in an aquatic ecosystem is determined by many physical, chemical and biological factors[2, 3].Lakes are superb habitats for the study of ecosystem dynamics: interactions among biological, chemical and physical processes are either quantitatively or qualitatively analysed [4].

Most lakes are in different stages of degradation in various ways - through eutrophication, toxic pollution or habitat loss. In addition the catchment based activities have been accompanied by encroachment on lake-shores by reclaiming shallow lake margins, sewage disposal, water abstraction, and diversification of in-lake recreational activities. All these activities directly cause rapid degradation of lakes.

As lake receives organic pollutants from industry, sewers and households, these pollutants are decomposed in the water and consume the dissolved oxygen in it, where this oxygen is crucial for aquatic ecosystem. This water is termed as grey water.Lake water quality deterioration has become a serious concern worldwide due to increase in population and climatic changes. Such deterioration threatens the use of lake water for domestic usage.It is necessary to determine a lake's physical, chemical, and biological properties to understand the lake's condition and helps in making lake management decisions. To conduct this experiment DorekereLake was suitably selected.

DorekereLake is on 28 acres and is located in the southwest part of Bangalore.A 1 MLD STP was constructed in 2010 which discharges treated water into the lake.The STP consists of a primary, secondary followed by tertiary treatment unit. Primary treatment includes bar screening, grit chamber, oil traps, equalization tank and a sedimentation tank. Secondary treatment includes aeration tank, clarifier, flash mixer tank, clariflocculator. Tertiary treatment includes pressure sand bed filter, disinfection unit.Though the STP has been established, due to improper maintenance and low efficiency of the treated water, the lake water has still major concentration of pollutants and requires immediate treatment. To overcome this, we have proposed a tertiary treatment unit.

II. Materials

Materials used for testing physical, chemical and biological parameters of water are,glassware such as burette, pipette, conical flask, beakers, sample bottles for collection of specimen, hand gloves, china dish, filter paper, glass rod. Instruments such as pH meter, glass electrode, conductivity meter, hot air oven, COD digester, spectrophotometer. Materials used for fabrication includes activated charcoal bed, collection tank, sand and gravel bed, disinfection unit(using bleaching powder), algae filter(chlorella vulgaris).

III. Methodology

Samples were collected from Dorekere Lake. During sampling 20 litres of water was collected in a polythene container. Water samples collected for the purpose of estimation of various parameters were brought to the laboratory and subjected to analysis to know the phsicio-chemical characteristics of water sample[5].

The parameters analysed in laboratory are listed as follows:
1) Colour, odour, taste, turbidity.
2) pH (hydrogen ion concentration) method.
3) Dissolved oxygen by Azide modification method.
4) Biological oxygen demand.
5) Total hardness by EDTA titrimetric method.
6) Total Suspended solids.
7) Nitrate by PDA method.
8) Iron by Phenanthrolin method.
9) Sodium and Potassium by flame photometer.
10) Heavy metals: Zinc, Cadmium, Lead, Nickel, Chromium.
11) Chemical oxygen demand.
12) Turbidity by Nephlometer.

After analysing the physico-chemical parameters of water sample, suitable treatment units was fabricated to further enhance the water quality. The Design details of fabricated treatment units are as given below.

Design details:
- The unit is made up of acrylic and glass.
- Initially the water was treated using algae (chlorella vulgaris) for about 9-12days.
- After the algal treatment, the water was next sent into the filtration unit.
- The filtration unit was composed of 3 beds/layers, that is, the top layer was a gravel bed with coarse aggregates of size 1.18mm to 300microns. The second layer was a sand bed with fine aggregates of size 6.7mm to 12mm. The final bottom layer consisted of an activated charcoal bed. The charcoal was washed and powdered for better efficiency.
- Collected water through the filtration bed was the disinfected using bleaching powder.
- After the treatment, the water quality parameters was tested again to check the improved quality of the lake water and efficiency of the treatment.

IV. Results and Discussion

The initial characteristic of water before treatment is tabulated below in table1.

Table 1: Initial characteristics of lake water before treatment.

SL NO	NAME OF THE TEST	EQUATIONS	CHEMICALS USED	RESULT	DESIRABLE LIMIT
01	pH Method followed: IS 3025(PART-11) : 1983	Not applicable	Buffer solution prepared using pH tablets or powder of 4.7 and 9.2.	8.48 (basic in nature)	6.5-8.5
02.	Total hardness(as CACO3) Method followed: IS 3025(PART-21): 2009	Total hardness= $\frac{\text{AX1000X c}}{\text{ml of sample taken}}$	Buffer solution, EDTA solution.	321mg/L	300mg/L
03.	Iron Method followed: Phenanthrolin method	Iron concentration = $\frac{\text{amount of ironX 1000}}{\text{ml of sample taken}}$	Phenanthrolinsolution,ammoniuma cetatebuffer, standard iron solution, hydroxylamine HCL solution.	0.28mg/L	0.3mg/L
04.	Turbidity Method followed: Turbidity by	Not applicable	Hydrazine sulphate, Hexa methylene tetramine.	12.6 NTU	10 NTU

	Nephlometer.				
05.	COD Method followed: IS 3025(PART58):2006	COD= $\frac{(A-B)X\ MX\ 8000}{\text{ml of sample taken}}$	• Std.K2CR2O7 digestion solution. • Sulphuric acid reagent. • Ferrion indicator. • Std FAS solution.	90.6mg/L	NILL
06.	Dissolved oxygen Method followed: IS 3025(PART44):1993	DO= $\frac{(\text{ml X N })\text{of ttrnt X 8000}}{V2\ X(V1-V)/V1}$	• Mangnous sulphate solution • Conc.sulphuric acid • Starch indicator solution • Std.sodiumthiosulphate solution	6.6mg/L	1.5mg/L
07.	Total dissolved solids Method followed: IS 3025(PART16):1984	TDS= $\frac{[(W2-W1)X10^6]}{\text{ml of sample}}$	--------	704ppm	500ppm
08.	BOD Method followed: IS 3025(PART44):1993	BOD= $\frac{(\text{ml X N })\text{of ttrnt X 8000}}{V2\ X(V1-V)/V1}$	• Phosphate buffer solution • Magnesium chloride solution • Calcium chloride solution • Ferric chloride solution • Distilled water	8mg/L	3-5 mg/L
09.	Nitrates Method followed: Nitrates by PDA method	Nitrate conc= $\frac{\text{amount of nitrateX 1000}}{\text{ml of sample taken}}$	• Phenol disulphonic acid • Std.nitrate solution	52mg/L	45mg/L
10.	Heavy metals: i. Copper i. Zinc i. Cadmium v. Lead v. Nickle i. Chromium	IS 3025(PART42):1992 IS 3025(PART49):1994 IS 3025(PART41):1992 IS 3025(PART47):1994 Annexure L IS 13428 :2005 Annexure L IS 13428 :2005	----- ----- ----- ----- ----- -----	<0.05mg/L <0.01mg/L <0.01mg/L <0.01mg/L <0.01mg/L <0.05mg/L	0.05mg/L 5mg/L 0.01mg/L 0.05mg/L 0.01mg/L 0.05mg/L

DESIGN OF TREATMENT UNIT:

After analysing the initial characteristics of lake water, it was found that the water still contains pollutants/organics exceeding the permissible limit as specified by Bureau of Indian Standards and requires further treatment. Hence a suitable treatment units was fabricated for the further removal of organics/pollutants.

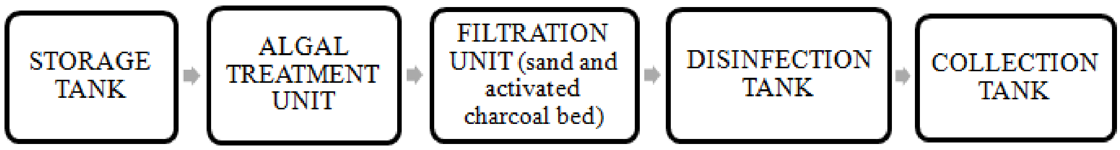

Fig1. Design layout consisting of various treatment units.

After the treatment of lake water the treated water sample was further analysed for removal of organics/pollutants. Table2 shows the removal of pollutants.

Table 2: Quality of water sample after the treatment.

SL NO	NAME OF THE TEST	EQUATIONS	CHEMICALS USED	RESULT	DESIRABLE LIMIT
01	pH Method followed: IS 3025(PART-11) : 1983	Not applicable	Buffer solution prepared using pH tablets or powder of 4.7 and 9.2.	8.1 (basic in nature)	6.5-8.5
02.	Total hardness(as CACO3) Method followed: IS 3025(PART-21): 2009	Total hardness= $\frac{AX1000X\ c}{ml\ of\ sample\ taken}$	Buffer solution, EDTA solution.	200mg/L	300mg/L
03.	Iron Method followed: Phenanthrolin method	Iron concentration = $\frac{amount\ of\ ironX\ 1000}{ml\ of\ sample\ taken}$	Phenanthrolin solution,ammonium acetatebuffer, standard iron solution, hydroxylamine HCL solution.	0.28mg/L	0.3mg/L
04.	Turbidity Method followed: Turbidity by nephlometer.	Not applicable	Hydrazine sulphate, Hexa methylene tetramine.	0.95NTU	10 NTU
05.	COD	COD= $\frac{(A-B)X\ MX\ 8000}{ml\ of\ sample\ taken}$	• Std.K2CR2O7	0.26mg/L	NILL

	<u>Method followed</u>: IS 3025(PART58):2006		digestion solution. • Sulphuric acid reagent. • Ferrion indicator. • Std FAS solution.		
06.	Dissolved oxygen <u>Method followed</u>: IS 3025(PART44):1993	DO= $\frac{(ml\ X\ N\ )of\ ttrnt\ X\ 8000}{V2\ X(V1-V)/V1}$	• Mangnous sulphate solution • Conc. sulphuric acid • Starch indicator solution • Std.sodiumthiosulphate solution	7.1mg/L	1.5mg/L
07.	Total dissolved solids <u>Method followed</u>: IS 3025(PART16):1984	TDS=$\frac{[\{W2-W1\}X10^6]}{ml\ of\ sample}$	--------	200ppm	500ppm
08.	BOD <u>Method followed</u>: IS 3025(PART44):1993	BOD= $\frac{(ml\ X\ N\ )of\ ttrnt\ X\ 8000}{V2\ X(V1-V)/V1}$	• Phosphate buffer solution • Magnesium chloride solution • Calcium chloride solution • Ferric chloride solution • Distilled water	3.2mg/L	3-5 mg/L
09.	Nitrates <u>Method followed</u>: Nitrates by PDA method	Nitrate conc= $\frac{\text{amount of nitrateX 1000}}{\text{ml of sample taken}}$	• Phenol disulphonic acid • Std.nitrate solution	20mg/L	45mg/L
10.	Heavy metals: i. Copper i. Zinc x. Cadmium x. Lead i. Nickle i. Chromium	IS 3025(PART42):1992 IS 3025(PART49):1994 IS 3025(PART41):1992 IS 3025(PART47):1994 Annexure L IS 13428 :2005 Annexure L IS 13428 :2005	----- ----- ----- ----- ----- -----	<0.05mg/L <0.01mg/L <0.01mg/L <0.01mg/L <0.01mg/L <0.05mg/L	0.05mg/L 5mg/L 0.01mg/L 0.05mg/L 0.01mg/L 0.05mg/L

Fig. 2(a) Fig. 2(b)

Fig. 2(a) and (b): DorekereLake

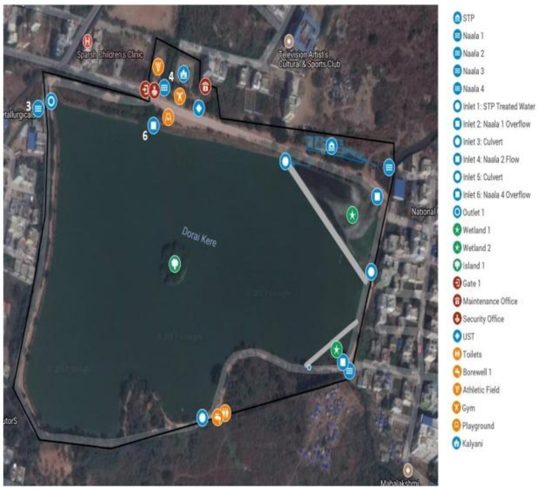

Fig. 3: Satellite view of the lake

Fig. 4: contamination of the lake

V. Conclusion

The water quality of Dorekere Lake has exaggerated due by the consequent changes and urbanization, which indicated the physico-chemical concentrations of lakes found in high levels. Total Dissolved Solids, Phosphates and Nitrogen have found to be exceeding their limits prescribed by the Bureau of Indian Standards showed the demanding pollution load on the lake. Despite of some conservation efforts made by the authorities this lake is threatening immeasurably [6]. Water treatment is available in Dorekere Lake but is inadequate. So the above mentioned method should be considered.Continuous monitoring of lakes should be enacted properly as from the origin point at the end to overcome these situations. This monitoring also helps in keeping the connectivity of lakes conscious [6].

The outcome generated from this project is that there is increased water quality of the lake. An economic treatment methodology is provided. This helps in better maintenance of lake and improves its biodiversity.This treated water can be used for domestic proposes like gardening, washing of park pavements, filling up the kalyani located right beside the lake, etc. It can also be used for civil engineering purposes like mixing of mortar, curing and preparation of pre-stressed concrete elements, hollow blocks, and etc. But one major drawback is that this method is deficient for portable water. Portable water requires further treatment which is tedious. And also this treatment is insufficient for treating industrial water.

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